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FINE SIZE CLASSIFICATION OF QUARTZ, BARITE AND TALC USING THE WALTHER LABORATORY AIR CLASSIFIER 150

P.R.A. Andrews
Mineral Processing Laboratory

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by

P.R.A. Andrews*

SUMMARY

A preliminary evaluation of the Walther air classifier was made using samples of -50 μm silica flour, and talc and -70 μm barite, to determine the separation cut point size for each mineral sample (the size at which there is a sharp separation into coarse and fine product fractions). For the silica flour and talc samples this value is ~11 μm whereas for the barite, with a higher specific gravity, the size is ~5 μm.

Based on this study the ability of the classifier to sharply separate minerals into coarse and fine fractions is only fair; furthermore, losses of material occurred in all tests. It is thought that these losses are mainly in the -5 μm range and should have been collected either in the fine product container (Product 2) or on the filter cloth (Product 3). There is evidence also that some of these losses were coarse 22 μm particles which should have been collected in Product 1.

This study was primarily concerned with determining and comparing the cut points of Products 1 and 2; Product 3 being difficult to recover from the interstices of the filter cloth, was therefore discounted. In the evaluation of results it is recognized that some of the losses are to Product 3.

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*Research Scientist, Non-Metallic Minerals Section, Mineral Processing Laboratory, Canada Centre for Mineral & Energy Technology, Energy, Mines, and Resources Canada, Ottawa.

CLASSIFICATION GRANULOMÉTRIQUE DU QUARTZ, DU BARYTE ET DU TALC À L'AIDE DU SÉPARATEUR PNEUMATIQUE WALTHER 150 DE LABORATOIRE

par

P.R.A. Andrews*

RÉSUMÉ

Ce rapport présente les résultats d'une évaluation préliminaire du séparateur pneumatique Walther faite à l'aide d'échantillons de farine siliceuse et de talc à -50 µm et de baryte à -70 µm, afin de déterminer la dimension de la maille de coupure pour chaque échantillon de minéraux (c.-à.-d. une dimension où il y a une nette séparation des fractions grossières et fines du produit). Dans le cas des échantillons de farine siliceuse et de talc cette dimension est de ≈11 µm tandis que pour le baryte, dont le poids spécifique est plus élevé, la dimension est de ≈5 µm.

D'après les résultats de cette étude, la capacité du séparateur de séparer nettement les minéraux en fractions grossières et fines a été jugée moyenne; de plus des pertes de matériaux se sont produites dans tous les essais. On pense que ces pertes sont principalement de l'ordre de -5 µm et qu'elles auraient dû être recueillies soit dans le récipient du produit fin (produit 2), soit sur la toile filtrante (produit 3). On a la preuve aussi que certaines pertes étaient des grains grossiers de 22 µm qui auraient dû être recueillis dans le produit 1.

Le premier but de cette étude était de déterminer et de comparer les mailles de coupure des produits 1 et 2; on n'a pas tenu compte toutefois du produit 3, vue la difficulté de le récupérer des interstices de la toile filtrante. Lors de l'évaluation des résultats, on a reconnu que certaines pertes appartenaient au produit 3.

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*Chercheur scientifique, Section des minéraux non métalliques, Laboratoire du traitement des minéraux, Centre canadien de la technologie des minéraux et de l'énergie, Énergie, Mines et Ressources Canada, Ottawa.

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INTRODUCTION

In conjunction with the evaluation of fine grinding equipment by the Non-Metallic Minerals Section of the Mineral Processing Laboratory, it is necessary also to evaluate fine classification equipment. One such fine particle separator is the Walther laboratory air classifier 150, manufactured by Walther and Cie, Aktiengesellschaft, Koln-Dellbruck, West Germany and distributed in Canada by Buhler-MIAG Canada, Toronto, Ontario.

DESCRIPTION

The following description and operating procedure of the classifier is a summary of information supplied by MIAG-North America, Inc.[1].

The Walther air classifier consists essentially of a feeding device, air classifier with built-in fines collector, and a cloth filter. The feeding device consists of a plexiglas hopper which holds the material to be classified. The material is fed through an adjustable slot with the aid of an adjustable vibrating feeder into two classifier inlets. Once material has entered the classifier, separation of coarse from fine particles is effected by centrifugal forces, caused by the creation of an air vortex within the classifier. The coarse particles are thrown to the outside of the separation zone, where they fall through a slot at the periphery into the coarse particle container (Product 1). The drag force caused by the air vortex carries the fine particles through a central opening in the bottom of the separation zone into the centrifugal fines separator inside the classifier, where a further fine from very fine particle separation takes place. The fine fraction is subsequently discharged into Product 2 and the very fine particles are carried out with the air and are recovered on the cloth filter (Product 3).

An important feature of this unit is a metering device for the secondary air by which the classification process can be adjusted. The final products are collected in three plexiglas containers. The entire unit is covered by a tight fitting plexiglas hood.

OPERATION

When starting the classifier, the secondary air valve is closed. After the vacuum pump motor has reached full speed, the secondary air control lever is set to the desired flow rate, measured in m^3/h. The secondary air valve is then opened sufficient only for the floating cone in the air stream to reach the marker in the glass measuring tube. The vibrating feeder is then started to feed material into the two classifier inlets.

The feed rate can be adjusted by either raising or lowering the feed hopper for coarse regulation or by increasing or decreasing the vibration with the control knob at the feeder for fine regulation. The feed input to the classifier may have an effect on the air flow rate which should be re-adjusted after the classifier is in operation. After the sample has passed through the classifier, the secondary air valve is closed and the vacuum pump motor stopped. Finally, when the pump has come to a complete stop and the plexiglass hood has been removed, any fine particle dust which adheres to the side walls of the instrument during the operation is brushed down into the appropriate containers. Products 1 and 2 are then weighed and as much Product 3 as possible is recovered from the filter cloth. Size analysis is conducted using sub-micron sieves.

Generally Products 2 and 3 contain no coarse material but Product 1 may contain some fine material. If this is the case, the size analyses of these products will show whether further reclassification is necessary.

PRINCIPLE OF OPERATION

The separation into coarse and fine fractions at a certain particle size is dependent on the flow rate of air, such that the greater the flow rate the coarser the separation size. The accuracy of separation depends on the granulation of the material to be classified, consequently the maximum particle size of feed should not be >60 µm. Other factors which influence the accuracy of separation are moisture content, low feed rate, and reclassification of fractions.

The separation cut point for the Walther is quoted as between 5 to 7 μm for material of specific gravity between 0.5 to 2.0 and at 2 μm for material of specific gravity between 3 to 8[1].

SCOPE OF STUDY

Since the particle size cut point is dependent on the air flow rate, the initial approach was to determine specifically how the cut point size varies with the air flow rate using a sample of very fine, 60 μm silica flour and a slow feed rate. Once the air flow rate corresponding to 5 μm, the lowest cut point size for quartz[1], had been established, a repeat run with silica flour using the same air flow rate was conducted with reclassification of the coarse and fine fractions, to determine whether reclassification would improve the efficiency of separation.

Finally, preliminary tests were conducted on samples of fine barite and talc to determine at what cut point size these minerals would be classified, using the same air flow rate as for the silica flour.

TESTWORK PROCEDURE

Several 100 g portions of silica flour, barite and talc were prepared. Prior to evaluation each sample of barite and talc was ground for 10 min in a laboratory ceramic ring pulverisor to ensure that the maximum particle size would be <60 μm. An additional test was conducted on a sample of unground barite which was essentially <70 μm. The silica flour, being <60 μm, needed no further grinding. The size analysis of each mineral prior to classification is presented in Table 1.

Each 100 g portion of mineral was added to the feed hopper and fed to the classifier at a rate of 25 g/min, with the air flow rate set at a particular value. After completion of each test any fine particle dust which adhered to the side walls of the instrument during the operation was brushed into the appropriate Product 1 or Product 2 containers. An attempt was made to recover Product 3 but this was impractical due to the difficulty of recovering ultra-fine particles from the filter cloth. In view of this difficulty no attempt was made to recover Product 3 in the subsequent testwork.

Each product was then weighed to determine weight loss and from each product, 1 g was removed for size analysis using sub-micron sieves at 22, 11 and 5 μm. This procedure was accomplished by placing the finest 5 μm sieve in a bath of alcohol such that the sieve mesh surface was just immersed below the surface. The -5 μm particles were then separated by applying ultrasonic vibrations to the bath. It was necessary to use alcohol rather than water since water has a higher surface tension than alcohol, which factor affects sizing in the fine micron ranges. After drying, the +5 μm was weighed and -5 μm was determined by difference. This procedure was then repeated using the 11 μm and 22 μm sieves.

DISCUSSION OF RESULTS

The results of a trial run conducted on silica flour using an air flow rate of 30 m^3/h are shown in Table 2. It is apparent from these results that there is a separation cut point at ≈5 μm.

A more detailed series of tests using silica flour were conducted where the effect of increasing the air flow rate was investigated while maintaining the feed rate at 25 g/min. The air flow rate was increased by increments of 5 m^3/h from 5 to 30 m^3/h. The results of these tests are shown in Table 3.

These results show trends rather than precise cut points. It appears that separation in the finer sizes is best using a moderately low air flow rate of 10 m^3/h and that separation at coarser sizes is best using a higher air flow rate of 20 m^3/h. There was also some contamination of fine particles in the Product 1 and to a lesser extent coarse particles in the Product 2. Losses of fines were high and tended to increase with an increase in air flow rate (discounting the anomalous high loss of fines in the 5 m^3/h test). What is further perplexing is that these losses were not only from the -5 μm range but also from the -22 +5 μm range, which can be seen from the reconstituted feed % weight values. In what proportion these losses should have reported to either Product 1, 2 or 3 is also uncertain, although it is probable that the majority would report to both Product 2 and 3.

The test results reported in Table 3 show unexpected results; high losses of fines and uncertainty as to the size range in which these losses occurred. A more detailed test program was designed where duplicate tests were conducted using silica flour at 10, 20 and 30 m^3/h air flow rate, with Product 1 and Product 2 of A series sized at 22 µm and Product 1 and Product 2 of B series (duplicate test) sized at 5 µm. The feed rate was maintained constant at 25 g/min. The results of the duplicate series of tests are reported in Table 4. As before, losses of fines were noted, but now the problem was further complicated by the unreproducibility of the losses between duplicate tests.

It is clear, when examining the reconstituted feed % weight values of A series, that the losses occur in the -22 µm fraction when using air flow rates of 10 and 20 m^3/h. At 30 m^3/h air flow rate losses also occurred in the +22 µm fraction as might be expected with a higher air flow rate. Considering the B series, the reconstituted % weight feed values indicate that the losses occur both in the +5 µm and -5 µm fractions. There is a suggestion that, at the higher air flow rates, losses would occur mainly in the -5 µm fraction as the % weight values for -5 µm decreased from 8.8% at 10 m^3/h, to 2.6% at 30 m^3/h, while the total losses of fines increased from 8.2% to 13.7% for the same increase in air flow rates. As noted with the previous test series, the proportion in which these losses should have reported to either Product 1, 2 or 3 is uncertain, although it is probable that the majority would report to both Product 2 and 3.

The results of testwork to this point indicated that an intermediate air flow rate of 15 m^3/h should be sufficient and that the cut point size of silica flour was in the -22 + 5 µm size range. A final test was conducted on silica flour using 15 m^3/h air flow rate, with reclassification of the coarse and fine product fractions. The results of this test are reported in Table 5.

The results of Run 1 through the classifier produced a loss of 7.9%, which from the reconstituted feed % weight values was mainly attributed to the -5 µm range. The efficiency of split measured as the % weight of a particular size range occurring in both Product 1 and Product 2 and expressed as a percentage, an indication of the cut point size, revealed an ~100% split at 11 µm. There was, however, still a substantial quantity

of -11 µm fines in Product 1. When Product 1 from Run 1 was repassed through the classifier (Run 2) some of the -11 +5 µm misplaced material was reduced from 23.4% to 12.3% but the reduced portion was accounted for as losses and not as reporting to the -11 +5 µm size range of Product 2 - Run 2. The efficiency of split between Products 1 and 2 of Run 2 again indicated an ≈100% split at 11 µm. When Product 2 from Run 1 was repassed through the classifier (Run 3) there was a similar ≈100% efficiency of split at >11 µm, but since ≈80% of the sample reported as losses only qualitative conclusions can be inferred.

A test conducted on fine talc using an air flow rate of 15 m^3/h and 25 g/min feed rate, the results of which are reported in Table 6, shows a more pronounced cut point at 11 µm. The losses account for 20% of the sample but from where they originate cannot be determined as a discrepancy exists in the -11 +5 µm size range, which suggests that this size fraction was incompletely sized.

A similar test conducted using fine barite, the results of which are reported in Table 7, was inconclusive due to excessive losses which accounted for 37.5% of the sample. The reconstituted feed % weight shows that losses occurred in each size range from +22 µm through to -5 µm, in fact very little classification was evident. It is thought that this was due to a combination of high specific gravity and low feed rate. By increasing the feed rate to 150 g/min, but maintaining the air flow rate at 15 m^3/hm, better results were obtained (see Table 8); it is evident that the cut point of barite is ≈5 µm. This test was qualitative rather than quantitative as the losses of fines were not recorded.

CONCLUSIONS AND RECOMMENDATIONS

When using a feed rate of 25 g/min, a sample of -50 µm silica flour was classified best using an air flow rate of 15 m^3/h. A sample of -70 µm barite required a higher feed rate of 150 g/min for adequate classification, but the air flow rate was sufficient at 15 m^3/h.

The separation cut point of -50 µm silica flour and talc is ≈11 µm and, for -70 µm barite, ≈5 µm.

These conclusions are tentative since unaccountable losses occurred in every test. These losses are thought to be mainly -5 μm fines which should have reported to Products 2 and 3. There is also evidence to suggest that coarser, 22 μm particles were lost as well. The losses may be minimized and the classification efficiency improved by using a higher feed rate, the rated feed rate capacity being between 7.5 to 450 g/min[1]. Certainly for barite when the feed rate was increased to 150 g/min the classification was improved. Based on the conditions used in this study, however, it would seem that the Walther air classifier does not produce sharp cut points and that losses, especially of fines, are excessive.

ACKNOWLEDGEMENTS

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REFERENCE

1. Anon "Manufacturers technical information"; MIAG North America Inc., Minneapolis, Minn.; 1960.

Table 1. Size analysis of minerals

Size (μm)	Silica Flour	Talc	Barite 1	Barite 2*	Dolomite
+ 22	43.1	35.0	14.0	35.0	18.5
-22 + 11	33.9	22.5	22.0	17.6	21.9
-11 + 5	10.7	19.0	48.5	37.5	52.6
-5	12.3	23.5	15.5	9.9	7.0
Total	100.0	100.0	100.0	100.0	100.0

*Essentially <70 μm

Table 2. Trial run to establish separating cut point size of silica flour

Airflow: 30 m^3/h

Size (μm)	Head % wt	Product 1 % wt	Product 2 % wt
+ 22	43.1	57.0	0.5
-22 + 5	44.6	38.8	28.2
-5	12.3	4.2	71.3
Total	100.0	100.0	100.0

Table 3. Effect on separation cut point size of silica flour with increasing airflow rate

Size (μm)	Head % wt	5 m^3/h % wt	10 m^3/h % wt	15 m^3/h % wt	20 m^3/h % wt	25 m^3/h % wt	30 m^3/h % wt
Product 1		75.7	86.3	78.1	79.8	75.0	59.3
Product 2		1.0	1.9	2.5	1.8	4.8	14.2
Loss		23.3	11.8	19.4	18.4	20.2	26.5
Total		100.0	100.0	100.0	100.0	100.0	100.0
Product 1 size analysis							
+22		45.0	43.2	41.4	41.8	41.0	36.2
-22 + 5		26.7	37.4	33.8	36.1	31.4	21.6
-5		4.0	5.7	2.9	1.9	2.6	1.5
Total		75.7	86.3	78.1	79.8	75.0	59.3
Product 2 size analysis							
+ 22		0.5	0.0	0.0	0.0	0.1	0.0
-22 + 5		0.4	0.6	1.7	1.4	3.4	10.9
-5		0.1	1.3	0.8	0.4	1.3	3.3
Total		1.0	1.9	2.5	1.8	4.8	14.2
Reconstituted head							
+22	43.1	45.5	43.2	41.4	41.8	41.1	36.2
-22 + 5	44.6	27.1	38.0	35.5	37.5	34.8	32.5
-5 μm	12.3	4.1	7.0	3.7	2.3	3.9	4.8
Total	100.0	76.7	88.2	80.6	81.6	79.8	73.5
Loss		23.3	11.8	19.4	18.4	20.2	26.5

Table 4. Duplicate tests conducted on silica flour to determine effect on separation size for airflow rates of 10, 20 and 30 m^3/h

Size (μm)	Head % wt	10 m^3/h % wt (A)	10 m^3/h % wt (B)	20 m^3/h % wt (A)	20 m^3/h % wt (B)	30 m^3/h % wt (A)	30 m^3/h % wt (B)
Product 1		79.3	82.7	77.4	78.6	57.9	68.8
Product 2		1.8	9.1	8.8	11.6	14.3	17.5
Loss		18.9	8.2	13.8	9.8	27.8	13.7
Total		100.0	100.0	100.0	100.0	100.0	100.0
Product 1 size analysis							
(A) (B)							
+22 +5		41.9	80.7	41.3	78.4	35.9	67.1
-22 -5		37.5	2.0	36.1	0.2	22.0	1.7
Total		79.3	82.7	77.4	78.6	57.9	68.8
Product 2 size analysis							
(A) (B)							
+22 +5		0.1	2.3	0.1	10.9	0.6	16.6
-22 -5		1.7	6.8	8.7	0.7	13.7	0.9
Total		1.8	9.1	8.8	11.6	14.3	17.5
Reconstituted feed							
(A)							
+22	43.1	42.0		41.4		36.5	
-22	56.9	39.1		44.8		35.7	
Total	100.0	81.1		86.2		72.2	
(B)							
+5	87.9		83.0		89.3		83.7
-5	12.3		8.8		0.9		2.6
Total	100.0		91.8		90.2		86.3
Loss		18.9	8.2	13.8	9.8	27.8	13.7

Table 5. Classification of silica flour with reclassification of primary products at 15 m^3/h airflow rate

Run 1

Size (μm)	Coarse Prod. % wt	Fine Prod. % wt	Feed Recon. % wt	Feed Meas. % wt	Efficiency of Split Prod. 1 %	Prod. 2 %
+ 22	40.3	-	40.3	43.1	100.0	-
-22 + 11	20.2	0.3	20.5		98.7	1.3
-11 + 5	23.4	6.2	29.6	44.6	79.1	20.9
-5	1.6	0.2	1.8	12.3	87.6	12.4
Total	85.5	6.7	92.1	100.0		
Loss			7.9			

Run 2: Reclassification of Product 1 from Run 1

Size (μm)	Coarse Prod. % wt	Fine Prod. % wt	Feed Recon. % wt	Feed Meas. % wt	Efficiency of Split Prod. 1 %	Prod. 2 %
+ 22	44.8	0.1	44.9	40.3	99.8	0.2
-22 + 11	16.3	0.3	16.6	20.2	98.4	1.6
-11 + 5	12.3	2.0	14.3	23.4	85.5	14.5
-5	0.5	0.1	0.6	1.6	85.9	14.1
Total	73.9	2.5	76.4	85.5		
Loss			9.1			

Run 3: Reclassification of Product 2 from Run 1

Size (μm)	Coarse Prod. % wt	Fine Prod. % wt	Feed Recon. % wt	Feed Meas. % wt	Efficiency of Split Prod. 1 %	Prod. 2 %
+ 22	0.2	-	0.2	-	100.0	-
-22 + 11	0.2	-	0.2	0.3	100.0	-
-11 + 5	0.7	0.3	1.0	6.2	70.0	30.0
-5	-	-	-	0.2	-	-
Total	1.1	0.3	1.4	6.7		
Loss			5.3			

Table 6. Classification of fine talc

Coarse product	53.4	Airflow Rate 15 m^3/h
Fine product	26.6	
Loss	20.0	
Total	100.0	

Size (µm)	Coarse Prod. % wt	Fine Prod. % wt	Feed Recon. % wt	Feed Meas. % wt
+ 22	12.5	0.1	12.6	35.0
-22 + 11	23.0	0.1	23.1	22.5
-11 + 5	17.4	25.8	43.2	19.0
-5	0.5	0.6	1.1	23.5
Total	53.4	26.6	80.0	100.0

Table 7. Classification of fine barite, sample No. 1

Coarse product	57.2	Airflow Rate 15 m^3/h
Fine product	5.3	
Loss	37.5	
Total	100.0	

Size (µm)	Coarse Prod. % wt	Fine Prod. % wt	Feed Recon. % wt	Feed Meas. % wt
+ 22	7.5	-	7.5	14.0
-22 + 11	13.9	-	13.9	22.0
-11 + 5	34.6	5.1	39.7	48.5
-5	1.2	0.2	1.4	15.5
Total	57.2	5.3	62.5	100.0

Table 8. Classification of fine barite, sample No. 2

Feed Rate 150 g/min: Air Flow Rate 15 m^3/h

Size (μm)	Coarse Prod. % wt	Fine Prod. % wt	Feed Recon. % wt	Feed Meas. % wt
+ 22	33.5	-	33.5	35.0
-22 + 11	17.2	-	17.2	17.6
-11 + 5	29.7	1.6	31.3	37.5
-5	7.6	10.4	18.0	9.9
Total	88.0	12.0	100.0	100.0